EXTENDED REPORT

Hip pain onset in relation to cumulative workplace and leisure time mechanical load: a population based case-control study

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Ann Rheum Dis 2003;**62**:322–326

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Accepted 26 August 2002

Objective: In an unselected community sample of adults, to assess the role and importance of exposure to mechanical factors both at work and leisure in the aetiology of hip pain.

Method: A population based prevalence case-control study. Cases and controls were identified from a population survey of 3847 subjects registered with two general practices in Cheshire, United Kingdom. All subjects received a postal questionnaire which inquired about hip pain during the past month. An occupational history was obtained, including exposure to each of seven physical demands. Information was also obtained on history of participation in eight common sporting activities.

Results: 88% of those invited to participate returned a completed questionnaire. The 352 subjects with hip pain were designated as cases, and the remaining 3002 subjects as controls. In people ever employed, hip pain was significantly associated with high cumulative workplace exposure (before onset) of walking long distances over rough ground, lifting/moving heavy weights, sitting for prolonged periods, walking long distances, frequent jumping between different levels, and standing for prolonged periods. Odds ratios (ORs) in the higher exposure categories ranged from 1.46 to 2.65. Cumulative exposure to three sporting activities was significantly associated with hip pain: track and field sports, jogging, and walking, with odds ratios varying between 1.57 to 1.94. On multivariate analysis three factors were independent predictors of hip pain onset: cumulative exposure of sitting for prolonged periods (higher exposure *v* not exposed: OR=1.82, 95% confidence interval (CI) 1.13 to 2.92), lifting weights >50 lb (23 kg) (OR=1.74, 95% CI 1.06 to 2.86) (both relating to the workplace), and walking as a leisure activity (OR=1.97, 95% CI 1.32 to 2.94). The population attributable risk associated with each of these activities was 21%, 13%, and 16%, respectively

Conclusions: Cumulative exposure to some workplace and sporting "mechanical" risk factors for hip osteoarthritis (OA) appear to be related to hip pain in general—some (but not all) have previously been related to hip OA. Because these are common workplace or leisure time activities their attributable risk is high.

Hip pain among patients referred to hospital clinics can arise from many causes, the most common of which are osteoarthritis (OA), trochanteric bursitis, and referred pain from other structures such as the spine.[1] The pattern of causes of pain varies with age—for example, at young ages developmental disorders are common, but overall hip OA is considered to be the most important underlying disorder. However, the association between hip OA and pain appears to be relatively weak. For example, a study in primary care recruiting patients over 45 years of age with a new onset of pain, which the general practitioner believed was arising from the hip, found that about half of the recruited subjects did not have any evidence of radiographic change.[2] Similarly, in the general population, Lawrence *et al* found only a weak association between radiographic change and pain.[3] Hip pain is, however, common; Frankel *et al*, in a United Kingdom population study of adults aged 35 years and over, found that 14% reported pain "on most days for a month or longer in the past year".[4] Thus, the extent of the morbidity burden will be underestimated by confining attention to those with both pain and radiographic change. For example, the population study of Lawrence *et al* of adults aged 55–64 years[3] found a prevalence of hip pain of 16% and 6% in men and women, respectively, which reduced to 5.5% and 3.4%, respectively, when considering pain *and* radiographic change (grade III-IV[5]).

Unlike pain in the hip area, the aetiology of other regional pain syndromes has been more intensively studied, and specifically the role of mechanical exposures. Studies of low back pain,[6–8] knee pain,[9 10] and shoulder pain[11] have demonstrated associations with various aspects of mechanical load. There is little information relating such factors to hip pain itself—although hip OA has been related to mechanical loading of the hip joint.[12 13] Indeed, specific occupational groups, such as farmers, have been noted as having particularly high rates of hip OA.[14 15]

The aims of the current study were therefore, in an unselected community sample of adults, to assess the role and importance of exposure to mechanical factors both at work and leisure in the aetiology of hip pain. Because current mechanical loading may be influenced by current symptoms we were principally concerned with cumulative (past) exposures in influencing the onset of symptoms.

METHODS

The design was a population based prevalence case-control study. To identify cases and controls we conducted a population survey of 3847 subjects aged 18–85 registered with two general practices in Cheshire, United Kingdom (and who

Abbreviations: BMI, body mass index; CI, confidence interval; OA, osteoarthritis; OR, odds ratio

Table 1 Comparison of patients (hip pain) and controls (no hip pain) by demographic characteristics

	Hip pain in the past month				
	Cases		Controls		
Demographic characteristic	No	%	No	%	p Value*
Sex					
Male	128	36.4	1518	50.6	<0.005
Female	224	63.6	1484	49.4	
Age group (years)					
18–39	46	13.1	817	27.2	<0.005
40–59	161	45.7	1394	46.4	
60+	145	41.2	791	26.3	

*Statistical significance assessed using χ^2 test.

were listed at the same address on the electoral register). Subjects were selected from practice lists by simple random sampling. One practice was in a commuting suburb south of Manchester, whereas the other was based in a former mill town. Together they provided a sample of subjects with a broad range of socioeconomic status. Subjects were mailed a questionnaire to complete themselves and non-responders were followed up by post and, where necessary, by telephone.

Identification of patients and controls

Subjects were asked on the questionnaire, "Have you experienced hip pain, during the past month, lasting at least 24 hours?". If so, subjects were asked when symptoms had first started. Respondents who answered positively to the question on hip pain were defined as cases, and all other subjects were defined as controls.

Measurement of occupational physical demands and leisure activities

Information was collected pertaining to an individual's history of exposure to occupational physical demands and leisure activities. Respondents were asked about their current job and all previous jobs held for one year or longer. For each job, information was requested on the age of starting and finishing the job and whether it involved each of seven physical demands (*a*) standing for at least two hours without a break; (*b*) sitting for at least two hours without a break; (*c*) lifting weights >50 lb (23 kg) by hand; (*d*) walking for more than two hours a day; (*e*) climbing more than 20 flights of stairs a day; (*f*) jumping or moving between different levels; and (*g*) walking for more than two hours a day over rough ground. This method of recording occupational physical demands has been used previously in community based pain studies and its construct validity demonstrated.[7]

Further items inquired about lifetime participation in eight common sporting activities: swimming, track/field, tennis, badminton, football, walking, running/jogging, and cycling. Respondents were asked to indicate the age they started/stopped the activity and for how long, on average, it was carried out a week; three response options were provided (<1 hour a week, 1–4 hours a week, and >4 hours a week).

Statistical analysis

For cases, cumulative exposures were measured until the time of onset of hip pain—"the reference date". To determine a comparable reference date for controls, each control was randomly allocated a case from a list of all cases who were within five years of age and the same sex as the control. The reference date of the selected case was then allocated to the control for the purposes of determining the end time point for measuring cumulative exposure.

For analysis, the cumulative duration of each occupational physical demand was categorised into three groups: (*a*) no exposure; those with some exposure (*b*) above and (*c*) below the median. Person-hours of leisure time exposure were calculated for each activity by ascertaining the length of time spent carrying out the activity in years (age at which they stopped minus the age at which they started), converting years into weeks and multiplying by the hourly frequency of the activity using the following values: <1 hour a week =0.5 hours, 1–4 hours a week = 2.5 hours, and >4 hours a week = 6 hours. Three exposure categories were derived in an analogous manner to occupational demands. Logistic regression was used, and associations were summarised as odds ratios (ORs) with 95% confidence intervals (95% CI); all were adjusted for five-year age groups and sex.

To identify which of the occupational demands and leisure activities were independently associated with hip pain a stepwise multivariate logistic regression analysis was carried out comprising all factors found to be significantly associated with hip pain in the univariate analysis. All analyses were conducted using Stata Corporation software.[16]

Ethical approval for the study was obtained from the local research ethics committees.

RESULTS

In total 3847 subjects were mailed a postal questionnaire. After two repeat mailings to non-responders, 3385 completed questionnaires were received, an 88% response rate. The one month period prevalence of hip pain lasting at least 24 hours was 10.5% (n=352). The 352 subjects with hip pain were designated as cases, and 3002 subjects as controls (for 31 people hip pain status could not be established). Cases, in comparison with controls, were more likely to be older and female (table 1).

Occupational physical demands

Among the participants, 1003 reported not having been employed or provided incomplete information, leaving 2382 subjects for analysis. In people ever employed, hip pain was significantly associated with high cumulative workplace exposure (before onset) of walking long distances over rough ground, lifting/moving heavy weights, sitting for prolonged periods, walking long distances, frequent jumping between different levels, and standing for prolonged periods. Odds ratios in the higher exposure categories ranged from 1.46 to 2.65 (table 2).

Sporting activities

Among the participants, 2217 reported current or previous participation in at least one sporting activity. Of the eight common sporting activities investigated, cumulative exposure to three was significantly associated with hip pain: track and field sports, jogging, and walking. Odds ratios amongst those in the highest exposure category were 1.94, 1.82, and 1.57, respectively (table 3).

Table 2 Association of occupational physical demands with hip pain

Cumulative exposure to occupational demands in years before symptom onset	Hip pain in the past month			
	Cases	Controls	OR*	95% CI†
Standing >2 hours				
Not exposed	53	692	1.00	–
1–15 years	52	606	1.19	0.80to1.78
16+ years	71	576	1.46	1.00to2.14
Sitting >2 hours				
Not exposed	39	649	1.00	–
1–17 years	66	599	1.94	1.28to2.95
18+ years	70	607	1.82	1.19to2.77
Lift/move weights >50 lb (23 kg)				
Not exposed	94	1104	1.00	–
1–12 years	26	394	0.99	0.63to1.58
13+ years	52	369	1.90	1.30to2.78
Jumping between different levels				
Not exposed	120	1316	1.00	–
1–14 years	21	282	0.93	0.57to1.52
15+ years	35	257	1.52	1.00to2.30
Walking >2 miles a day				
Not exposed	81	1049	1.00	–
1–14 years	41	410	1.43	0.96to2.13
15+ years	55	405	1.65	1.13to2.41
Walking >2 miles a day on rough ground				
Not exposed	150	1687	1.00	–
1–6 years	9	75	1.43	0.68to2.98
7+ years	15	74	2.65	1.43to4.90
Climbing >20 flights of stairs a day				
Not exposed	128	1430	1.00	–
1–13 years	20	207	1.33	0.80to2.19
14+ years	25	211	1.40	0.87to2.25

*Odds ratio adjusted for age and sex; †95% confidence interval.

Multivariate analysis

Of the six occupational physical demands and three sporting activity variables offered as candidate variables to a stepwise model, three were entered in the final model. These were the cumulative exposure of sitting for prolonged periods (higher exposure *v* not exposed: OR=1.82, 95% CI 1.13 to 2.92), lifting weights >50 lb (23 kg) (OR=1.74, 95% CI 1.06 to 2.86) (both relating to the workplace), and walking as a leisure activity (OR=1.97, 95% CI 1.32 to 2.94). The population attributable risk associated with each of these activities was 21%, 13%, and 16%, respectively (table 4).

DISCUSSION

We have investigated the possible influence of mechanical exposures on hip pain in the community. Data from primary care suggest that in about half of new cases of pain arising from the hip, there may be no evidence of radiographic change—and therefore it is important to evaluate aetiology across all causes. Furthermore, even in cases where pain and radiographic change do coexist, this may not represent a causal link, given the independent presence of either. As far as we know, this population based study is the first to investigate both occupational and leisure activities in relation to hip pain. A number of occupational activities involving both mechanical loading of the hip joint (walking for extended periods and occupational lifting) and maintaining a fixed posture (sitting/standing for extended periods) were found to be related to the onset of hip pain. In addition, high cumulative exposure to activities involving repetitive use and mechanical loading of the hip joint during leisure time were found to be associated with hip pain (running/jogging, walking, and track and field).

A number of methodological issues need to be considered in interpreting the study results:

Firstly, the study relied on self reports for both hip pain and physical occupational and leisure activities, giving rise to the possibility of recall bias or misclassification, or both. We attempted to minimise the likelihood of recall bias by collecting exposure information before inquiry about hip pain and by ascertaining cumulative exposure to occupational factors only until the time of onset of the hip pain (cases) or until a "dummy" date (controls) in the case-control analysis. Non-differential misclassification might have influenced the study findings with inaccuracies in recalled lifetime exposures and the duration of hip pain applying equally to both cases and controls. However, such misclassification attenuates associations and therefore the true influence of these occupational and leisure activities is likely to be stronger than reported here.

Secondly, one in eight of the population eligible to participate did not complete the postal questionnaire. Those subjects who did not respond were more likely to be younger men (the group least likely to have hip symptoms). The prevalence estimate of hip pain reported in this study might, therefore, be slightly greater than the true population prevalence. However, the main findings of our study would change only if the relation between the physical activities and hip pain differed between participants and non-participants and there is no reason for supposing that this is the case.

Thirdly, for practical reasons, this study was restricted to measuring occupational physical activities as part of paid employment and did not attempt to measure physical activities carried out during work in the home. It is likely that such activities would also play a part in the development of hip pain, particularly in women.

Fourthly, adjustment for potential confounders in the current study was restricted to age and sex. Ideally, it would have been useful to include information relating to body mass index (BMI), known to be related to the onset of hip symptoms, in the multivariate analysis. Unfortunately, data relating to height and weight have been found to be very poorly recorded by self reports owing to both missing data and inaccuracies.[17] For this reason we did not inquire about these variables. If BMI did act as a confounder to the relationship between mechanical factors and hip pain, it is likely that associations would be attenuated (the likelihood being that BMI is positively associated with hip pain and negatively associated

Table 3 Association of leisure activities with hip pain

Cumulative exposure to leisure activities in hours	Hip pain in the past month			
	Cases	Controls	OR*	95% CI†
Swimming				
Not exposed	127	1052	1.00	–
26–780 hours	29	212	1.31	0.84to2.02
781+ hours	93	684	1.21	0.90to1.61
Track/field				
Not exposed	216	1738	1.00	–
26–780 hours	15	116	1.32	0.75to2.33
781+ hours	18	94	1.94	1.13to3.33
Tennis				
Not exposed	211	1573	1.00	–
26–988 hours	19	189	0.76	0.46to1.26
989+ hours	19	186	0.57	0.34to0.95
Badminton				
Not exposed	212	1601	1.00	–
26–728 hours	19	170	1.04	0.63to1.72
729+ hours	18	177	0.78	0.47to1.29
Football				
Not exposed	209	1573	1.00	–
26–1690 hours	20	186	1.09	0.64to1.84
1691+ hours	20	189	1.12	0.66to1.91
Walking				
Not exposed	135	1147	1.00	–
26–3250 hours	33	429	0.68	0.46to1.02
3251+ hours	81	372	1.57	1.15to2.13
Running/jogging				
Not exposed	211	1609	1.00	–
26–832 hours	12	177	0.78	0.42to1.46
833+ hours	26	162	1.82	1.14to2.90
Cycling				
Not exposed	173	1381	1.00	–
26–1430 hours	37	288	1.19	0.81to1.74
1431+ hours	39	279	1.01	0.69to1.49

*Odds ratio adjusted for age and sex; †95% confidence intervals.

Table 4 Occupational and leisure physical activities independently associated with hip pain

	Hip pain in the past month			
	Cases	Controls	OR*	95% CI†
Cumulative exposure to occupational demands before symptom onset				
Sitting >2 hours				
Not exposed	39	649	1.00	–
1–17 years	66	599	2.00	1.24to3.21
18+ years	70	607	1.82	1.13to2.92
Lift/move weights >50 lb (23 kg)				
Not exposed	94	1104	1.00	–
1–12 years	26	394	1.02	0.58to1.80
13+ years	52	369	1.74	1.06to2.86
Cumulative exposure to sporting activities (hours)				
Walking				
Not exposed	135	1147	1.00	–
26–3250 hours	33	429	0.95	0.57to1.57
3251+ hours	81	372	1.97	1.32to2.94

*Odds ratio adjusted for age, sex, and all physical activities significantly associated with hip pain in the univariate analysis; †95% confidence interval.

with physical activities at work and during leisure). Therefore, the associations we have identified between mechanical factors and hip pain in the current study are likely to be stronger.

Finally, it is possible that some of the hip symptoms seen in this study group might have been referred pain from the lumbar region; 161/352 (46%) subjects with hip pain also reported some back pain in the previous month. There is therefore likely to be some overlap between mechanical risk factors for low back and lower limb regional pain syndromes. For example, prolonged working postures and manual handling of weights during work have also been found to be associated with low back pain.[7 18] However, walking (both at work and during leisure time) and jumping between different levels have not been found to be a risk factor for low back pain and seem to be exclusively related to hip symptoms (walking during leisure time was an independent predictor for hip pain).

Few studies have been carried out investigating the occurrence of hip pain in the general population. For this reason, and because of variations in the definition of hip pain used, it is difficult to compare our estimates of the prevalence of hip pain with those of previous studies. A cross sectional

study of more than 28 000 UK adults aged 35 years or older identified 14.3% with hip pain "on most days for one month or longer during the past 12 months".[4] Our estimate of the one month period prevalence of hip pain in this age group was slightly lower (326/2763; 11.8%). The National Health and Nutrition Examination Survey (NHANES III) also identified a prevalence estimate of 14.3% in adults aged 60 years or more, with "significant hip pain on most days over the past six weeks".[19] The one month period prevalence in this age group in the current study was similar (145/936; 15.5%). The prevalence estimates derived from this study therefore seem to be consistent with those obtained in other population based studies.

Given the paucity of research looking at the occurrence of hip pain (generally) in the community and the relationship of physical occupational and leisure activities with hip symptoms, the results from our study have been considered in regard to other published reports of hip disease. There is little previous evidence to suggest that cumulative exposure to walking during leisure time is related to hip disease. It has been suggested that higher levels of recreational physical activity performed as a young adult are associated with a modest increase in both radiographic and symptomatic hip OA,[20] but specific recreational activities, such as walking, were not differentiated. In addition, the association between prolonged sitting at work with hip pain, is new. Results from a case-control study of subjects awaiting hip arthroplasty found that being seated for prolonged periods (>2 hours) in the workplace was less common among the cases (OR=0.5, 95% CI 0.3 to 0.9).[21] There is, however, considerable evidence suggesting an association between occupational lifting and hip OA.[15 22] In a study of farmers, an almost 10-fold increase in the risk of hip OA was identified in farmers who had farmed for over 10 years (in comparison with sedentary workers), with this excess risk being attributed to heavy lifting.[22] Another study compared 611 male and female patients listed for hip replacement due to OA with an equivalent number of controls, and observed that men who had regularly lifted weights in excess of 50 kg for 10 years or more had an OR=3.2 (95% CI 1.6 to 6.5).[21] The authors did not observe an association between occupational lifting and hip OA in women. In contrast with this observation, our study found a stronger association between occupational lifting (in the highest tertile of exposure) and hip pain in women (OR=2.4, 95% CI 1.4 to 4.0) than in men (OR=1.5, 95% CI 0.9 to 2.5).

In summary, this study provides evidence that some workplace and sporting "mechanical" risk factors for hip OA appear to be related to hip pain in general. Others associated with hip pain have not been reported as risk factors for hip OA and have not been investigated for hip pain generally. Finally, the work activities of lifting heavy weights, prolonged sitting, and walking as a common leisure activity had a population attributable risk of about 50%, reflecting both the strength of associations found and that these activities are common.

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